The CORNELL ENGINEER

I WOULD FOUND AN INSTITUTION WHERE ANY PERSON CAN FIND INSTRUCTION IN ANY STUDY

IN THIS ISSUE

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by

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Number 6

STRESS CONCENTRATION STUDY IN STRUCTURAL PARTS

By the
PHOTOELASTICITY DEPARTMENT AT CORNELL UNIVERSITY

This Month and Next

W. K. FRANK, ME '11 presents a clear picture of the manufacture of copper-clad steel wire and at the same time gives us an interesting resume of the historical developments leading up to the present type of wire. Mr. Frank is rather well connected with Cornell; while at Cornell he was Business Manager of the SIBLEY JOURNAL and was also active in the various musical clubs. He also has two sons who are Cornell men, Thomas W. Frank, AE-ME '38, and James A. Frank, AE-ME '40. After graduation from Cornell Mr. Frank was connected with the Damascus Bronze Co. of Pittsburgh until he went to the Copperweld Steel Co., of which he is now vice-president. He is also on the board of United Engineering and Foundry Co. of Pittsburgh, makers of rolling mill equipment.

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HAROLD A. BAXTER, ChE '38 gives us a good idea of the engineering difficulties a chemist may become involved in in his article on the design of a sodium hydroxide plant. This article is an abstract of the original, a 250 page report in which Mr. Baxter gives complete cost and structural data on every detail of the plant, from the building itself down to the smallest unit.

While at Cornell Mr. Baxter established a brilliant scholastic record, graduating at the head of his class. He was awarded the Caldwell prize for scholastic excellence and was a member of Phi Kappa Phi.

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TELL BERNA, ME '12, is a familiar figure at Cornell. Seniors will recall him as a frequent lecturer on the general subject of industrial economics, and as general manager of the National Machine Tool Builders Association, Geneva Branch. He is indeed a well qualified speaker.

Mr. Berna should also need no introduction to the alumni. During his undergraduate career he made his place as one of Cornell's track immortals by setting several track records, and in addition was generally very active on the campus.

In this issue Mr. Berna presents the lecture he made to senior engineers recently. Those of us who heard the lecture felt that it was vitally interesting to engineering men and that the ENGINEER would do well to pass it on.

The

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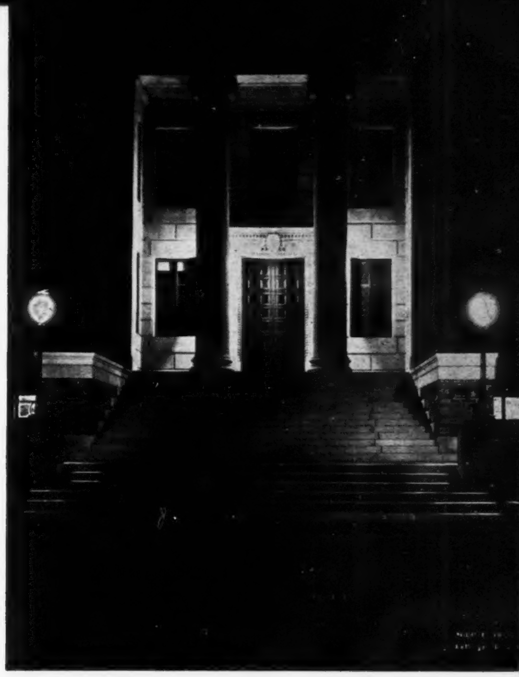

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Specifications for A Man

"To respect my country, my profession, and myself. To be honest and fair with my fellow men as I expect them to be with me. To be a loyal citizen of the United States. To speak of it with praise and act always as a trustworthy custodian of its good name. To be a man whose name carries prestige with it whereever it goes.

"To base my expectations of a reward on a solid foundation of service rendered. To be willing to pay the price of success in honest effort. To look upon my work as an opportunity to be seized with joy and to be made the most of, not as a painful drudgery to be reluctantly endured.

"To remember that success lies within my own self and in my own brain, my own ambition and my own courage and determination. To expect difficulties and force my way through them. To turn hard experience into capital for future struggles.

"To believe in my profession heart and soul. To carry an air of optimism in the presence of those I meet. To dispel all temper with cheerfulness, kill doubts with strong conviction, and reduce action with an agreeable personality.

"To make a study of my business. To know my profession in every detail. To mix brains with effort and system in my work. To find time to do every needful thing by not letting time find me doing nothing. To hoard days as a miser does dollars. To make every hour bring me dividends in increased knowledge and healthful recreation. To keep my future unencumbered with debts. To save as well as to earn.

"To cut out expensive amusements until I can afford them. To steer clear of dissipation and guard my health of body and peace of mind as a most precious stock in trade.

"Finally to take a good grip on the joys of life. To play the game like a man. To fight against nothing as hard as my own weakness and endeavor to give it strength. To be a gentleman and a Christian so I may be courteous to man, faithful to friends, and true to God."

Found among the papers of Thomas J. Van Alstyne, former engineering student, Cornell University, after his death on the job.- Cornell Civil Engineer, 1915 Vol. 23, p. 154

Machine-Made Jobs

How They Are Created When The Individual's Productivity Is Increased, As Presented To Our Senior Engineers

By Tell Berna M.E. '12

General Manager of National Machine Tool Builders Assn.

THIS time of strain and crisis at home and abroad occasionally leads someone to say that you, as the coming generation, will have to solve the problems that we, who got our training in an earlier day, have failed so dismally to solve. This, I suspect, is a bit bewildering to you because of the very size and complexity of our national problems, to say nothing of the difficulties of Europe. It is a little like having an elephant sit on your lap.

But these problems are not new—for the most part they go back to the dawn of civilization. We have been trying to solve them for centuries, and there has been very decided progress in the last forty years.

Attempts to solve them overnight will probably fail—they always have. We may never solve them completely but we are determined that the progress we were making before the depression must be resumed and in this you will play your part. For the advances in our standard of living are due to the increased productivity that results from an increase in the use of the machine and of electrical power, and we need today more than ever, the engineering type of mind. We need it not merely in design and manufacture, but to give us an engineering point of view in approaching our economic problems. We need more citizens who form opinions only after finding as many facts as possible on which to base them, and we need a better understanding of economic forces.

We seem to be afflicted with too much haste, too much emotion, and too much wishful thinking. The result is an attempt to solve problems by oversimplifying them. Every man has a "right" to a job—this is a rich country, our citizens must have better medical attention—the old are "entitled" to security. All of these ends are praiseworthy, but that's not news. We have always wanted them, but we are hardly going to attain them by placing so great a burden on our producers that we wreck our entire industrial structure.

A great deal of harm is done by failure to define our objective before going ahead. Thus we have the Secretary of Agriculture drawing farm lands out of production while the Secretary of the Interior carries out a vast program of soil reclamation.

Sometimes the straight line between two points isn't the shortest way there, if I may scramble my metaphors. We attempt to establish higher wage rates by legislative fiat because we don't want to wait until increased efficiency in production will make higher wages possible. American trade and industry are very complex and the proponents of such legislation have failed to trace these ideas through to their end-results. Consequently we are attempting experiments on a national scale that are fore-doomed to failure.

There are two opposed schools of thought. One says that if we compel employers to pay more money, the workers will spend more, that means more business for everyone, increased employment and prosperity. That reasoning leaves out just one important

detail. The margin of profit can't absorb the higher costs resulting from higher wage rates when they have not been preceded by increase in efficiency. So prices go up, and people will not buy. And you can't make people buy by passing a law.

The other theory is advanced by hard-headed industrialists. They suggest that if we can increase output per man-hour, we can raise wages, perhaps even shorten hours, or lower our sales price, or do all three of these things, and still return a profit on the manufacturing operation. The result is increased sales and better business, resting on a firm foundation.

Under those conditions people with money will invest it in business, and economists of every shade of thought seem to regard that as the crying need today. We can't make people invest if they don't happen to feel like it.

To substantiate this theory, we may examine the record. From 1899 to 1937 there have been the following changes in this country:

Population	up	72%
Number fully employed	up	89.8%
Length of average work week	down	19.5%
Power used	up	330%
Wages paid—in dollars	up	499%
Real wages	up	109%
Output per worker	up	283%

To this reasoning the objection is still being made that, carried too far, mechanization creates unemployment. To this charge the machine tool industry is very sensitive. The entire development of American industry rests, in the last resolution, on the machine tool and the products of the machine tool.

Obviously, better automobiles are the direct result of the better materials, better design, increased production, and greater accuracy of finish, and of these the last two are the fruit of the close cooperation of the automobile manufacturer and the machine tool builder in devising better and still better machine tools.

Even in an apparently unrelated field, as foodstuffs, we find the products of the machine tool used, in cultivating, planting and harvesting the crop, in bringing it to market, in processing and packing.

To be sure, the reason for installing a better machine is to reduce direct-labor costs. What does happen when a machine is bought? From long observation in selling machine tools, I'd say they are bought when

(1) Business is good; production is falling behind sales; old machines are a bottle neck in the production line. New equipment increases output, with no change in the number employed.

(2) Competition makes better quality imperative; new methods mean greater accuracy, finer finish. Here again, we have no change in the number employed.

(3) A new product is to be manufactured. This hasn't happened often enough in recent years. It means increased employment, of course. We'll have more of this type of buying when investors again feel justified in venturing our vast store of latent capital in new enterprises.

(4) Competition forces lower prices, which must be met by means of better methods.

The last situation does, on occasion, result in "technological" unemployment. We have the much quoted instance for the cigarette-making machine that threw fifty women out of work in a little southern town. To be sure, better and cheaper cigarettes result in increased employment in warehousing, distribution, and increased sales for the tobacco farmer. But that is scant consolation for these fifty women. This mis-adjustment constitutes a real problem, one which many executives recognize and deal with in a constructive way. If they can't, the community must assume the responsibility.

This type of unemployment is not inevitable when new machines are bought. I have in mind one large enterprise that has long had a firm policy of finding work for such displaced workers. In our own industry good men are so hard to find, that we are anxious not to lose them, and this doesn't happen to be one of our problems. Unless a depression forces his hand, the machine tool builder makes every effort to retain his skilled men. Even a slight upturn in present business levels will result in a shortage of trained mechanics.

I hope that we are even now, as a nation, preparing to abandon hasty methods, and return to the slow, laborious processes that have proven helpful in past years. There is still plenty of room for improvement in industry. We all know that the railroads are burdened with an enormous accumulation of obsolete equipment. In even our most progressive industries every works manager has his program calling for the replacement of equipment. Most of these machines are still in running order, but advances in design will make replacement profitable.

This, then is your opportunity. I hope you will all feel that these four years at Cornell have been only the beginning of your education. By all means plan to "serve your time" in the shop as the next step in that process. For that is the best way to become acquainted with the men with whom you will have to work. Every career, every career in the vast engineering field at least, depends for success on the ability to handle men—to succeed in your contacts with human beings. This, and a growing understanding of the economic forces that we must learn to control, is an essential element in the training of every engineer. I predict with confidence that even as you are doing more advanced work here in college than we did in our day, that you will eventually do a better job in industry than we are doing, and that your work will be of substantial value in building the better nation of tomorrow.

Copper Covered Steel Wires

Used Where Transmission Lines Need Corrosion Resistant Wire Of Very High Strength For Long Spans

By W. K. Frank, M.E. '11

FROM early times down to the present day, the desirability of combining the strength of iron or steel with the non-corrosive properties of copper has been appreciated. Primitive people probably realized the advantages obtainable by combining these two metals, since tools and weapons found in the ruins of ancient Assyrian cities, and among the remains of the Swiss Lake dwellers reveal the use of articles with an iron core and a copper alloy (bronze) covering.

Scientific literature and patent records of the 19th and 20th centuries record a constant effort to combine steel and copper to utilize the desirable properties of both. Probably the earliest patent on a process to accomplish this combination in a single product was issued in 1821 to Poole in England. By melting copper or brass in a shallow cast iron pan, he made pans which were protected from corrosion while the cast iron furnished the required strength. A few years later processes were developed for depositing copper on steel by electroplating, but these processes were limited in their practical application.

About this time wire manufacturing activity began. Steel, copper and brass were the metals commonly used for wire. However, with the advent of the electrical industry, wires were needed which had high strength, good conductivity, and non-corrosive properties. Steel wires, while strong, had poor electrical conductivity and corroded very rapidly. Copper did not corrode and was a good conductor, but was limited in strength. Thus the need for a high strength, non-corrosive conductor greatly accelerated efforts to develop a method for the manufacture of copper-covered steel wire. The chronological order of the more meritorious of these activities is of interest.

In the early 1860's, Farmer and Milliken made wires by wrapping copper strips around a steel wire and then tinning the wrapped wire. They made a number of interesting experiments on the electrical and physical characteristics of this wire, but commercially it was a failure. The pioneer patent on a telegraph wire using the casting process to combine

Figure E

The steel core is thoroughly cleaned, accurately centered in the mold, and heated before the molten copper is poured.

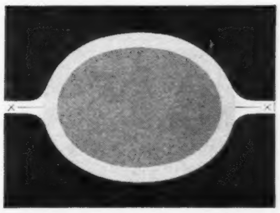


Figure C
When the copper is molten-welded to the steel core there is no separation of copper and steel during rolling, even though not supported by the rolls at the points marked "X".

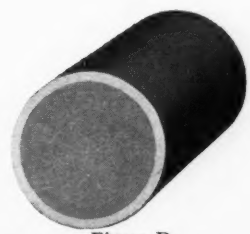


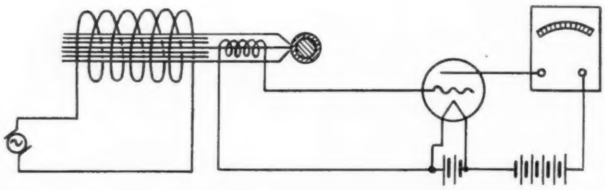
Figure D
Hot-rolling, cold-drawing, forging, bending, twisting or sudden temperature changes cannot destroy the molten weld of "Copperweld."

Figure F
Here, lack of weld in a copper-covered-steel bar caused the copper to spread away from the steel at the unsupported points, leaving gas filled voids between the metals.

these metals was taken out by the same men in 1865. Three years later, a method of casting steel into a copper mold was patented by a man named Park.

In 1885 Martin, in France, made a composite billet by placing a copper collar on the mid-section of a round steel billet, and then by rolling, spread the copper on the outer surface of the billet. This composite billet could be rolled and drawn into wire by careful handling. It did not make a satisfactory wire material, however. The copper existed as a shell over the steel core, each material retaining its own physical characteristics. Since the two materials were not joined (welded) together but only made variable mechanical contact, electrolysis was set up between the two metals and destruction would follow.

In 1883, a bimetallic wire composed of a steel core with an electroplated copper covering was being considered by one of the telegraph companies. They also tried using a compound wire having a steel core with a thin copper-plated covering surrounded by a wrapping of heavy copper strips. Neither wire had a bond or weld and the character of the copper varied with the conditions of plating. These objections, combined with high production costs, caused this process to be discarded.



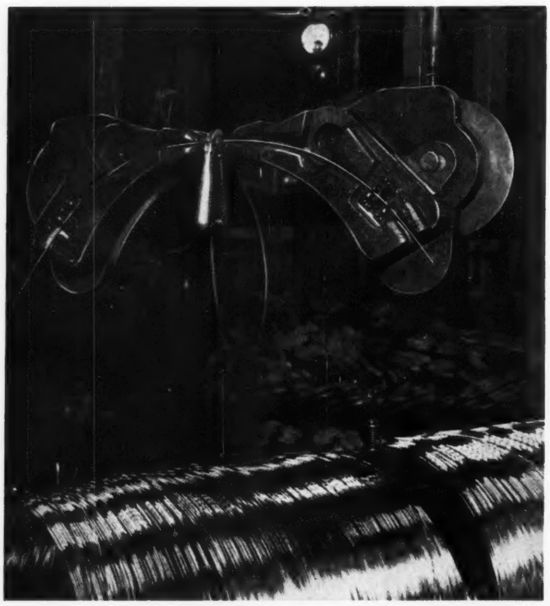


Figure H
Electro-magnetic Method of Measuring Thickness of Copper Covering

Further attempts were made in the '90's to manufacture bimetallic wire by mechanically forming a copper sheath over a steel wire similar to that of Farmer and Milliken, but were given up as failure after a year's work.

About 1900, a method of making copper-covered steel by a process similar in principle to the previous Martin's process was again attempted. A thin copper coating was electroplated on a steel billet, after which the billet was inserted in a seamless copper tube. This copper sheathed billet was then heated and rolled with the object of obtaining adhesion between the sheath and the core by means of rolling pressure. Considerable wire was made by this method, but the manufacture was later discontinued.

The Duplex Metals Company was organized in 1905 and did considerable experimenting on processes of welding copper and steel. Although the company was discontinued after several years, their experiments furnished a key to the problem of the combined use of steel and copper in a wire. Their method, the Monnot process, consisted briefly of dipping an especially prepared steel ingot in a copper bath, this operation wetting the ingot with copper. The ingot in a suitable mold was then placed in a second pot of molten copper and the mold filled, surrounding the steel core with copper to form the composite ingot. After cooling, the composite ingot was withdrawn from the mold and then hot rolled to rod and drawn to wire sizes.

This method secured good union between the steel and the copper. The composite rods or wire possessed the strength and toughness of steel and the electrical and non-corrosive properties of copper. No electrolysis took place between the steel and copper, and when the manufacturing processes were properly carried out, good wire material was produced. The process was quite complicated, however, and the intermediate steps of preparing the material very expensive. Considerable development was still necessary to control and simplify manufacturing operations in order to obtain a uniform product. Although the firm was disbanded in 1912, some of their wire is in use today.

In 1915, the Copper Clad Steel Company (name later changed to Copperweld Steel Company) began the manufacture of a copper-covered steel known as "Copperweld." Their process, which was less complex than previous methods, was based primarily on obtaining a molten weld between the copper and the steel in the composite ingot. No reliance was placed on rolling pressure as a means of uniting the two metals. Improvements and developments of this molten-welding process at last made possible the production of a wire combining the strength of steel with the life and conductivity of copper.

In this process, the steel in billets about 6 inches in diameter and 4 feet in length, is cleaned and fluxed and placed in a cylindrical graphite mold about 8

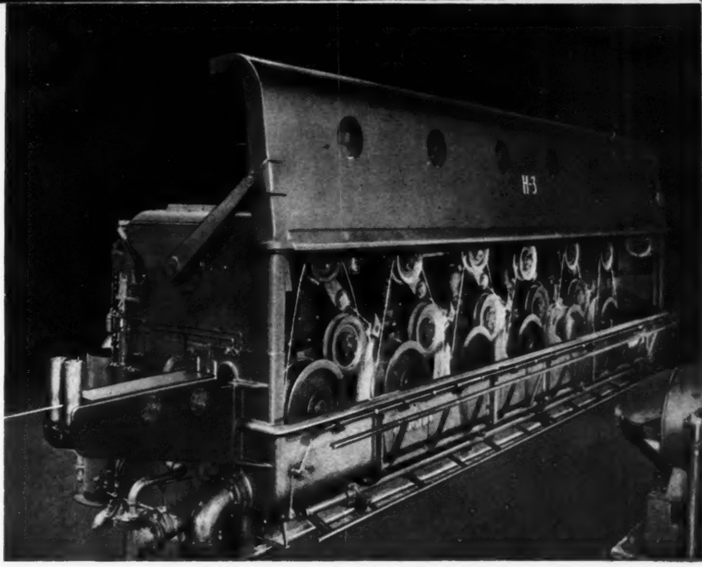


Figure G

"Copperweld" is cold drawn from ⅜" rods on modern continuous wire drawing machines

inches in diameter. The steel, thus prepared and carefully centered in the mold, is placed in a furnace and brought to a white heat. The mold, acting as a muffle, and the flux acting as a protective agent, prevent oxidation of the steel during heating. When the steel has reached a welding temperature, the mold is removed from the furnace and molten electrolytic grade copper is poured into it, entirely surrounding the heated steel billet. Being cast under these conditions, the crystals of copper and steel interlock forming a weld between the two metals. The cast ingot is removed from the mold after cooling and then reheated and rolled to the desired size by methods similar to those used in the manufacture of copper or steel wire rod.

As mentioned before, no reliance is placed on rolling pressure as a means of uniting the two metals in the production of copper-covered steel made by the molten-welding process. Instead, hot rolling the cast ingot serves as a positive and severe test of the weld between copper and steel in every inch of the material. The hot rolling test is designed to most vigorously test both the permanence and continuity of the weld by rolling the material in such a way as to break the copper from the steel if the slightest imperfection of the weld exists. Each pass through the rolls subjects the material to an exceptionally severe test, the object being not to bring about the artificial mechanical adhesion of the copper to the steel, but to test the weld, and if possible, separate the metals.

As will be seen in the Figure C the points marked "x" are unsupported by the rolls and any lack of union would immediately result in the spreading out of the copper away from the steel as shown in Figure F.

Because the copper covering is permanently and continuously molten welded to the steel core, the wire is free from microscopic cracks, fissures and pin holes that might admit moisture and permit any progress of electrolytic corrosion.

More rigid control, with added refinement in the manufacturing process, has resulted in copper-covered steel rods, wire, and strands of excellent quality and uniformity. Along with the improvements of the wire, tests and inspection practices suited to this type of wire have been developed, such as bend tests, test of weld, kink tests, test for surface, and also means of measuring the copper thickness at any point in a coil without destruction of the wire. Tensile strength, conductivity, minimum copper thickness, and the other physical properties are now controlled by rigid specifications.

Improvements in the art of rolling copper-covered steel ingots and rods developed by the Copperweld Steel Company, now make possible a guarantee of minimum copper thickness on "Copperweld" wire, as well as the earlier guarantee of minimum conductivity. This wire is manufactured in two grades of conductivity. Thirty per cent wire has an electrical conductivity equal to 30% of the conductivity of a solid copper wire of the same diameter, with a minimum copper thickness not less than 10% of the radius of the finished wire; forty per cent conductivity wire has an electrical conductivity not less than 40% of a solid copper wire of the same diameter, with a minimum thickness not less than 12.5% of the radius of the finished wire.

The older methods for measuring copper thickness on copper-covered steel wire required sample specimens cut from the coil of wire, from which the copper covering was removed chemically or mechanically, or microscopic examination of the end sections of finished wire. These were slow and required laboratory methods for obtaining accurate results. The improved method avoids the destruction of wire, and may be used to test the thickness of copper at any place in the entire length of the coil. Furthermore, the equipment is rugged and simple and the test rapid. Copper thickness measurements may be made right at the wire testing department along with conductivity and other standard tests.

The improved device for measuring copper thickness makes use of an electro-magnetic method. The layer of copper from the steel is non-magnetic, and therefore, acts the same as an air gap in a magnetic circuit. Consequently, a magnetic probe placed in contact with the surface of the wire indicates the length of the "air gap," or the distance from the surface of the wire to its enclosed steel core, thereby providing a measurement of the wall of copper at that point. The device is rotated around the wire so as to explore the thickness entirely around the steel core. The exact thickness of copper is indicated on a large meter placed in front of the inspector.

The principle of the device is simply that of an electric magnet having a projection extending from its iron core to serve as a probe. The general arrangement shown here is similar in principle to that of an ordinary transformer having a primary and secondary,

(*Continued on page* 24)

STUDENT TERM PAPER

On The Design of a Sodium Hydroxide Plant

This being a Brief of the 250 page required report

By HAROLD A. BAXTER, Chem. E. '38

EDITOR'S NOTE: With employers constantly seeking the technical man who can write a good report, emphasis is laid on report writing experience in several of our courses at Cornell. Heading the courses in the Chemical Engineering curriculum is the famed 730 with its 250 page report required of seniors in this school. This article is a condensed version of a representative report by a senior in Chemical Engineering and will serve to illustrate how comprehensive and detailed these reports become.

The action of lime on solutions of sodium carbonate has been known from early times. Berthollet discovered that the solution resulting from causicization could be purified by evaporation and treatment with alcohol. The product, known as "caustic soda, pure by alcohol," was, for a considerable time, assumed to be a simple substance. In 1807 Sir Humphrey Davy showed that by electrolysis is yielded oxygen and a new substance, sodium. He appears to have missed the hydrogen entirely. Berthollet, Gay-Lussac and Thenard, and Davy later showed that, instead of being the base formed by the combination of sodium and oxygen, caustic soda was the hydrate of that base.

The commercial development of the manufacture of caustic soda started as an outgrowth of the LeBlanc process for making soda ash. The crude "black-ash liquor" resulting from this process contained considerable caustic soda, which accumulated in the mother-liquor as the crystals of soda ash were removed.

In 1853, Gossage patented a process for the recovery of caustic soda by the concentration and partial dehydration of the mother liquor from the LeBlanc soda process. This product, called "Cream Soda," contained only about 60 per cent of Na_2O. In 1857 the manufacture of caustic from soda ash by the causticization process was begun. Milk lime (calcium hydroxide) was added to the black liquor, the calcium carbonate was filtered off, and the resulting solution of sodium hydroxide was concentrated and dehydrated.

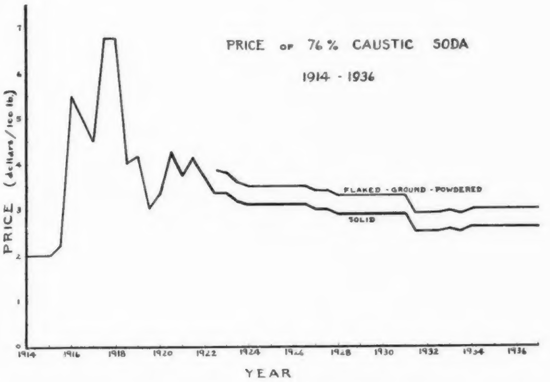
Up to this time, the commercial caustic soda was always colored by impurities. White anhydrous sodium hydroxide was not made commercially until 1860. At this time, Ralston described a process for the manufacture of white caustic soda by continuing the boiling after the strength of cream caustic had been obtained and simultaneously raising the temperature until the iron compounds settle from the clear molten caustic soda. About 1863 the Solvay ammonia-soda process became commercially successful. This provided a source of very pure sodium carbonate. By 1921, the Solvay process had replaced the LeBlanc process.

The modern method for making caustic soda by the causticization process is similar to that used sixty or seventy years ago, although the continuous method of operation is now being employed. Sodium carbonate solution and a strong suspension of milk of lime are agitated together at about 90°C for one hour as they pass through several causticizing agitators in series. The resulting solution then passes through a series of countercurrent thickeners in which the caustic solution is separated and the precipitated calcium carbonate is thoroughly washed. The underflow from the last thickener is filtered and sent to a rotary lime kiln where the calcium carbonate is reburned to lime to be used again in the causticization. The overflow from the first thickener is the strong caustic solution (about ten per cent) which passes into a multiple effect evaporator where it is concentrated to about fifty per cent before being sent to cast iron caustic pots in which the remaining water is removed and the anhydrous caustic produced.

The electrolytic process for making caustic soda is also of great commercial importance. As early as 1800, the action of an electric current on brine was known to produce an alkaline solution around the cathode. However, this knowledge could not be applied commercially at that time, because of the lack of a suitable source of electric current. When cheap electrical power became available, the process was again considered; by 1890 the Griesheim-Elektron Works in Germany was manufacturing caustic soda with the use of a diaphragm cell. This process, which was rapidly adopted in England, consists of the electrolysis of a saturated solution of purified rock salt in a cell in which an asbestos diaphragm separates the cathode compartment from the anode compartment. The chlorine formed at the anode is a product of major economic importance. The alkaline solution from the

cathode compartment is sent to evaporators, where it is concentrated and most of the salt is removed. From the evaporators, the concentrated solution passes to the pots in which the remaining water is removed.

Electrolytic caustic usually contains a small amount of sodium chloride as an impurity. This is not always objectionable, although it does interfere with the satisfactory use of the material for certain purposes.



Price Trends of Caustic Soda

The market price of caustic soda began to rise in 1915, when the domestic demand for use in the manufacture of war materials was felt. Large quantities were used in the production of synthetic phenol, which in turn was used in the manufacture of picric acid. This tremendously increased demand resulted in a sharp rise in price. Embargoes were placed on this commodity by several foreign countries and foreign consumers were forced to purchase in the United States. Export restrictions in 1917 forced the price of caustic to its highest level. At the beginning of 1918, by agreement between the Chemical Section of the War Industries Board and the manufacturers, the Government fixed a maximum price for caustic soda, applicable only to direct Government purchases. A gradual but steady decline in price followed in 1918 despite an apparent large shortage.

From 1919 to 1921, the price again rose markedly from its post-war low figure. This rise was brought about by the combination of a shortage of all sodium products and a large accumulated export demand due to the gradual return of foreign manufacture to normal conditions. However, this demand slowly dropped until 1923 when the export trade was very small. The price dropped and this drop was assisted by another complicating factor which was becoming increasingly important. Before the war the quantity of caustic soda produced by the electrolytic method was small; in the latter part of the war when the shortage became acute, electrolytic manufacturers were encouraged to expand, since there was also a good market for the chlorine which was produced in the process. At the close of the war the market for chlorine was endangered but the manufacturers developed new markets for chlorine and production was continued. The market for chlorine slowly became greater than that for electrolytic caustic and as a result there was an overproduction of caustic. This overproduction has continued for many years and has kept the price low and uniform. The manufacturers appear to have realized that cutting prices could not result in larger sales and would merely reduce their income. However, in about 1924 the price of caustic soda for export was reduced below the domestic price in an effort to dispose of some of the surplus. This condition still prevails. In 1931 there was an unnecessary price war which resulted in a decrease in price but there was probably not a single pound of caustic sold by this reduction which would not otherwise have been sold. Since then the price has remained steady.

The future price level of sodium hydroxide is somewhat in doubt. The overproduction continues and may lead to a dangerous situation. In an effort to dispose of the large surplus, a price war may be started. However, in 1936 several manufacturers were considering altering their plants to produce chlorine without obtaining caustic soda. This change has not yet taken place but it is a distinct possibility if production grows too much greater than consumption. On the whole, it appears that conditions will be stabilized so that the price of caustic soda will not fluctuate markedly in the near future.

Operation of the Plant

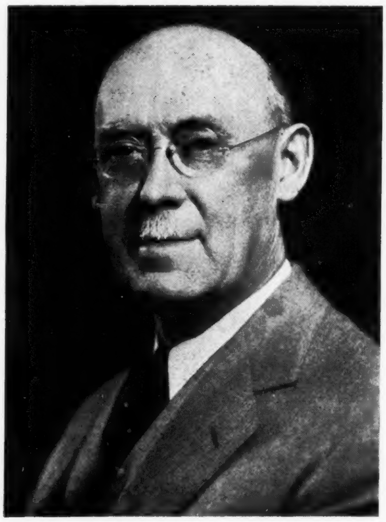
The plant is to have a capacity of fifty tons of caustic soda per twenty-four hour day. Since recent practice calls for the use of an increasing quantity of caustic in solution, this daily output will be divided into three parts: $16\frac{2}{3}$ tons in the form of a 50 per cent solution; $16\frac{2}{3}$ tons in the form of a 70 per cent solution; and $16\frac{2}{3}$ tons of solid caustic soda.

The principal raw materials are soda ash, lime and water. The soda ash is placed in storage in an outdoor silo. As required, it is moved from the silo on a conveyor belt to the soda hopper, which holds about a two-day supply. It passes from the hopper through an automatic feeder into the first of two solution tanks in series as is shown on the kinematic flow sheet. Two solution tanks are used to insure that the resulting solution of Na_2CO_3 will be uniform and of the desired concentration. The first tank overflows into the second, one hour being allowed in each. The solution from the second contains 10-15 per cent Na_2CO_3.

Lime for the process is obtained from two sources —fresh lime as purchased, and old lime which has been recovered by burning the calcium carbonate sludge in a rotary lime kiln. Approximately 10 per cent of the lime used is fresh, while the remainder is

(*Continued on page* 25)

Prominent Among Our Faculty



William Nichols Barnard M.E. '97

Director of Sibley School of Mechanical Engineering

DURING thirty-nine years of continued and devoted service Director Barnard has seen the Sibley School of Mechanical Engineering grow from infancy to its present respected position in engineering education. About 1890 Professor R. H. Thurston began, at Cornell, to place engineering instruction on a scientific basis and to develop a mechanical laboratory. During young Barnard's college days, the M. E. curriculum consisted mostly of shopwork, drawing, and lectures; it was often completed in three years by attending Summer School. (It is now often completed in four years by attending Summer School.)

Graduating in 1897, he served as an Instructor in the Machine Design Department until 1900 when he left to go to Indianapolis, where he was employed as a designer of municipal pumping engines. From there he traveled to the small town of Massillon, Ohio, this time to become a mechanical engineer with the Russel Engine Company. In 1903 he returned to the Machine Design Department and was given an assistant professorship. Appointed Professor of Steam Engineering in 1907, he served as Secretary of Sibley College under "Uncle Pete" Smith, then Dean of Sibley College. In 1938, he was appointed Director of the Sibley School of Mechanical Engineering after two years as Acting Director under deans Diederichs and Hollister.

Soon after the United States entered the World War, Professor Barnard was appointed President of the "Academic Board of the U. S. Army School of Military Aeronautics." He administered the ground school for training about 80 men per week in preparation for their intensive flying course at Kelley Field. Professors Ellenwood and Davis of the current M. E. faculty served in the Engine Laboratory Department of this school, and Professor O'Rourke of the C. E. School taught in the Airplane Laboratory.

The Cornell Cooperative Society, familiarly known as the "Co-op," has also felt Director Barnard's guiding hand. The store was formerly located in the basement of Morrill Hall. Under his leadership as president of the Cooperative Society (1924-30), it was moved from these inadequate quarters to its present location in Barnes Hall in 1926.

In the field of technical education Director Barnard has especially distinguished himself. His three volume treatise on heat-power engineering, written in collaboration with former Professor C. F. Hirschfeld and Professor Ellenwood of the Cornell faculty, is a standard text-book in the field. For twenty years, Cornell mechanical engineers have known him as the head of the highly important Department of Heat-Power Engineering.

Academic honors and recognition of his scientific contributions are signified by membership in Tau Beta Pi, Sigma Xi, Phi Kappa Phi, and Atmos. His keen interest in and support of the American Society of Mechanical Engineers, the Society for the Promotion of Engineering Education, and the Cornell Society of Engineers, are further evidences of his efforts to aid in the best training of engineers.

Director Barnard has literally grown up with the School of Mechanical Engineering, from its start as an insignificant school of Mechanic Arts. His burden of work has been one for a staunch man and Cornell has been fortunate in having him for the job; it is, however, his wealth of kindly and understanding counsel when guidance was needed that most Sibley graduates will recall when they return to deliver a non-resident lecture—or just to revisit the school during Cornell Day.

We of the *Cornell Engineer* staff, appreciating the aid Director Barnard has given our magazine and its predecessor "The Sibley Journal of Engineering," as one of the founders and advisors, feel happy to be able to let others know more about our able director.

Prominent Among Our Faculty

Everett Milton Strong
Professor of Electrical Engineering

THE sophomore EE's hear his ham sandwich analogue of a condenser in 410. All junior ME's and EE's stay awake in his lectures to catch the subtle remarks that he makes on the spur of the moment. In fact practically all engineers have come in contact at some time or another with Professor Strong. A master of the snappy comeback, he does a bang-up job of teaching by making the presentation and subject matter of his courses interesting.

Professor Strong spent his youth in Portland, Maine. His father was a mechanical engineer and he almost followed in his father's footsteps. However, at the end of his freshman year at MIT, even though he was taking the mechanical engineering course, he had to take some courses in the electrical engineering department, and found the electrical courses so interesting that he took others in the Electrical School and finally graduated with a BS in EE instead of an ME degree.

From MIT he went to the National Lamp Works of the General Electric Company in Cleveland. Here he did illumination engineering, plant maintenance work, and construction work, until 1924 when he came to Cornell.

Professor Strong is very active in electrical enginering circles as is evidenced by his membership in Eta Kappa Nu, AIEE, and IES. He is on the Committee on Papers and the Committee on Education in the IES. He is also a member of Acacia fraternity and the Masons.

Outside of the College he is interested in boating, sharing a small power boat with Mr. Cotner of the Electrical Engineering faculty. He likes music and frequently plays the violin, which will probably surprise many of his pupils. He has three young children and is especially interested in young people, being a Den Dad of a Cub Pack. His oldest son, age eleven, shows definite indications of becoming an engineer although his bent seems to be aeronautical as he has constructed numerous and intricate airplane models.

Professor Strong is also class advisor of the class of 1939. He finds this interesting as it gives him closer contact with the students. He serves on numerous school and college committees which proves that, contrary to the common conception, the faculty does do something besides grade prelims and play golf. (Ed: By the way, who play golf?)

—Courtesy of Baldwin Southwark
LIBRARY TOWER

CAMPUS CO

William Charles Chandler A.E.M.E. '39

"SPRING Day is going to be bigger this year than it has ever been," declared Bill "Goop" Chandler as he leaned back in his chair. From this we might have guessed that Bill is on a committee this Spring. Guess which?

Bill's recent election to Tau Beta Pi and his presidency of his fraternity, Sigma Nu, cause us to look for previous offices and academic merit in his record, and we find that at Brooklyn Prep he was class president and an outstanding student. Another endeavor that carried into his college career has been his running, for in high school he was on the two mile relay team which held the World's Indoor Scholastic Record. Here at Cornell he has won the McGinn Cross Country Cup, and rowed on the winning interfraternity crew of 1937 and the runner-up crew of 1938.

The summer before coming to Cornell, Bill and several of his friends drove to the San Diego Fair in California. The trip was a success except for an accident on the return trip in which Bill received several broken ribs. The summer of his sophomore year was spent on the maintenance crew of the Air Reduction Corporation in Jersey City. Last summer as an advanced course student in the R. O. T. C., Bill spent six weeks at Aberdeen Proving Ground, the Army ordnance camp. After graduation he would like to work in Sales Engineering for which he believes his Administrative Engineering course has given him excellent preparation.

Bill spends his spare time at home in his workshop. He has always been interested in making things himself, and is now building a small working model of an engine. He also finds time for swimming and the piano.

Perhaps we are on delicate ground, Bill, but didn't you steal a glance at that attractive co-ed's picture on your desk, when we asked what you feel indebted to Cornell for? If we were mistaken then what caused us to miss your reply completely?

Home Address: Brooklyn, N. Y.

Activities: Tau Beta Pi, Spring Day Committee, Kappa Tau Chi, Quill and Dagger, President of Sigma Nu, Business Staff of THE CORNELL ENGINEER, 2 years, McMullen Scholarship Holder.

William Hamilton Scott C.E. '39

"I'VE been working on the railroad" might well be "Bill" Scott's theme song, since he has spent two summers in Idaho with the Union Pacific Railroad realigning curves and building tunnels. Bill comes from far-west Omaha, where civil engineering is considered the most important of the engineering professions; hence his choice of a civil engineering career.

Besides being one of the top men in his class scholastically, Bill has participated in many and varied extracurricular activities, and has earned a good part of his expenses at Cornell by working in the engineering geology laboratory, and by waiting on table. He is also a recipient of a McMullen Regional scholarship.

One of Bill's extracurricular activities is debating, and right now he is looking forward to the challenge of a debate (with stakes at $20) made by the ASCE Junior members of Rochester to the ASCE Student Chapter of Cornell.

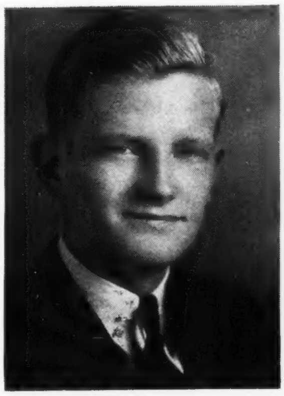
He has been so busy, in fact, that when asked what his hobby was, he admitted he had found no time for one, but some day he hopes to construct a radio set.

After graduating, Bill plans to enter the metallurgical industry, and hopes to obtain a position with an iron or steel company.

Home Address: Omaha, Nebraska.

Activities: Frosh 150 crew; Varsity crew squad 2, 3; Chairman, Junior Blazer Committee; Frosh Advisory Committee; Chi Epsilon, Corresponding Secretary 3, 4; Pyramid 3, 4; Crew Club; CE Honor Committee 1; Debate Club; McMullen Regional Scholarship; Treasurer and Steward Pi Kappa Alpha; 1st prize Fuertes Memorial Public Speaking 3; ASCE 1, 2, 3, pres. 4; McMullen Regional Association 1, 4, pres. 2, 3.

CO EMPORARIES



Robert B. Roe E.E. '39

COMING from a family of Cornellians, Bob Roe entered Cornell with the firm intention of becoming a communications engineer. However, during his freshman years, he became greatly interested in flying and took lessons at the Ithaca Airport. Now he is a qualified commercial pilot, and has turned his hobby into a paying asset by acting as student instructor at the Ithaca Airport. Bob has a very clear idea of what western New York State looks like since he spent last summer as a barnstorming pilot of a two-ton amphibian.

His first great "love" was radio, and starting as a "ham" during the latter part of his high school years, he became proficient enough to obtain summer employment as a radio operator aboard a passenger boat making the Buffalo-Duluth run on the Great Lakes. He was also "Sparks" on a private yacht which included Bermuda in its summer cruise along the Eastern Seaboard.

His mania of flying has not entirely supplanted his interest in radio. In fact, the two are very skillfully combined in the position he has obtained with the Sperry Gyroscope Company where he will begin work immediately after graduation.

Although he claims that studies sometimes tend to interfere with his full time hobby of flying, Bob has made a very creditable record at Cornell. His name has appeared on the Dean's List of the Engineering School for the past three years. Active in campus activities, he is very interested in the improvement of the aeronautical courses offered at Cornell.

Aside from the daily schoolwork, Bob's main interest might be said to be summed up in this statement: "When there is blue sky, and when the sun comes out, you'll find me down at the airport."

Home Address: Buffalo, New York.

Activities: Eta Kappa Nu, Phi Kappa Phi, A. I. E. E.

Udo Wilfried Fischer M.E. '39

ONE blustering day last fall a small low-powered monoplane rolled down the runway of the Ithaca airport, towing a glider on a long cable. Struggling into the air, the plane headed out over the choppy waters of Cayuga, carrying the glider behind it. In the tiny cockpit of the sailplane was Udo Fischer, Cornell's foremost exponent of the sport of gliding. At an altitude of fifty feet, the towing plane found the load too great, and refused to climb higher. Barely maintaining flying speed, the two craft strained to maintain altitude enough to get back to the safety of the airport. Once over the field, Udo cast loose and glided back to earth.

"That experience is probably the one I'll remember most vividly in my Cornell career," said Fischer after relating the story of his flight. Gliding has been Udo's chief interest while at Cornell, and he might be said to have fostered the rebirth of the Ithaca Gliding Club for it was his old Franklin Military glider that the Club purchased when he brought his graceful Mimona sailplane from Germany this fall. Since learning the sport in Germany in 1932, he has participated in several national gliding meets at Elmira during the beginning of his summer vacations. He also took part in another meet in Michigan one year. Just this last summer, Fischer returned to Germany and took a two weeks course in airplane towing at a flying school there.

While in Germany, Udo didn't get a chance to see any of the aeronautical factories, since the Germans were not publicizing their airforce then as they are now. However, he could not help noticing the antiaircraft practice which was being held around the field.

For one so interested in flying it is not surprising that Udo is taking the aeronautical option in his M. E. course. However, he is more interested now in the production end of manufacturing. He has worked for several summers in the assembly and drafting departments of his father's manufacturing company, and hopes to work permanently for the concern when he graduates.

Home Address: Mount Airy, Pa.

Activities: 150-Lb. Crew, Freshman Football, Advanced R. O. T. C., A. S. M. E., Atmos, Tau Beta Pi, McMullen Scholarship.

WITH THE ENGINEERS

MANY rumors have gone the rounds concerning the purpose of the large pit which has recently appeared in the floor of the west mech lab building. The local branch of sidewalk supervisors who have been following the construction activities have suggested everything from a swimming pool for summer school students to a bombproof cellar for the instructors to be used if enough students learn to fly and get up courage enough to "do something about that mech lab department."

As a matter of fact, the pit is to house a new traction dynamometer which will be constructed from his own plans by Louis Otto, Cornell graduate. The machine will probably not be in use before June, so don't worry about there being a new report to write.

•

AT LAST a ray of hope dawns for the haggard Seniors who have just begun chasing that elusive job up and down the halls of Sibley and in and out of the interview rooms. The numerous books, articles, lectures and demonstrations on what color tie to wear at an interview and how to present your personality to the personnel manager of the Siwash Nut and Bolt Company, which have haunted the lives of the Seniors lately are enough to make anyone worry, but here are some concrete facts that should dispel those gloomy clouds.

The latest survey of the Personnel and Employment office states that 94% of the the engineers who graduated last June are either employed or taking graduate work. Of the 148 men who possess the coveted sheep skin, 128 are employed, 11 have gone into graduate work, and 9 are "temporarily unoccupied." The Chemical and Administrative Electrical Engineers have perfect records of 100% employment, and the other schools are not far behind.

The round by round box score of the employer versus graduate battle is as follows:

Class	Number in Class	Positions Accepted	Graduate Work	Unemployed	Percent Occupied
AE-EE	10	10	0	0	100
Chem E	14	14	0	0	100
ME	43	35	6	2	95
AE-ME	39	36	1	2	95
EE	18	13	3	2	89
CE	24	20	1	3	87
	148	128	11	9	94

•

BUT enough of the search for jobs, and on to the more pleasant things in life.

Under this heading we find the Tau Beta Pi elections for the spring term. The new men elected from the senior class are:

William C. Chandler, John G. Tammen, Bruce L. Cormack, James J. Wilder, and Frederick F. Reimers.

And from the class of '40:

Crawford G. Adams, Joseph E. Griesedieck, Beach Barrett, Frederick G. Jaicks, Charles R. Baxter, Jr., Teh-Chang Koo, Melvin Blessing, Edwin P. Swatek, Jr., William E. Fisher, Jr., and William H. Worchester.

Another pleasant note is the fine showing made by Engineers on the campus in the recent appointments to the Senior Class Day, Senior Ball and Spring Day Committees. Of a total of 42 men on these committees, 15, or over one-third, are engineers.

Merton Gerhauser, Robert Mann, James Setright and Joseph Steele are the engineers on the Senior Class Day Committee. Chairman of the Senior Ball Committee is Bob Gifford, and members are Walter Gregg, George McMullen, Henry Simons, and Jim Wilder. On the Spring Day Committee we find William Chandler, William Flanigan, Aertsen Keasbey, Melvin Sevin, Beach Barrett, and Herbert Hilmer.

•

The officers of the A.S.M.E. are at present occupied with plans for the annual convention of the Student Branches of the Society in this area, which will be held at Cornell on April 14 and 15th. Delegates are expected from fourteen technical schools of the New York and New England district, and attendance will probably run close to the two hundred mark. The tentative program includes several technical sessions, an inspection trip, and luncheon, and a banquet. Winners of the speaking contests held at the various colleges will compete for the district awards.

Mr. Prior, district lubrication engineer for the Socony Vacuum Company presented a sound film entitled "The Inside Story of Lubrication" at the meeting of the society held on February 28th. The film emphasized the importance of the lubricants which make possible our mechanized civilization, and pointed out the many problems involved in their wide applications.

Mr. Francis Hodgkinson, America's foremost turbine designer, addressed the A.S.M.E. on "Steam Turbines" on March 14. Mr. Hodgkinson recently won the 1938 Holley Medal from the American Society of Mechanical Engineers for his distinguished service in this field.

Recently honored by associates in the Westinghouse Electric and Manufacturing Company on his retirement after 42 years, of service, Hodgkinson was a co-worker with Sir Charles Parsons and George Westinghouse in the development of steam turbines in England and the United States. He has been granted 101 patents in this field of engineering, and in 1925 won the Elliott Cresson Gold Medal of the Franklin Institute.

Mr. Hodgkinson traced the general procedure used in the design of a steam turbine and told several interesting stories of his experiences in the construction and operation of large units.

•

The annual A.S.C.E. Smoker was held February 21 in the Terrace Room of Willard Straight. Mr. H. H. Williams, director of the Cornell Placement Bureau, gave an excellent talk on "Preparation for Employment." Refresh-

ments were served following the speech.

How the water resources of the nation are accurately measured was described and illustrated February 28, by A. W. Harrington, district engineer of the U. S. Geological Survey. Harrington, '09 CE, is in charge of the Albany office of the Survey. His talk, amply illustrated, explained the recording gages, the weirs, and the recording stations which are used in the Water Resources Branch.

●

Two officials of the D. L. and W. Railroad spoke before the recently formed Railroad Enthusiasts club March 8. Earl Saunders, signal engineer, discussed the problems of his department, and Curtis Bayer talked on "Opportunities for College Graduates in the Railroad Industry." Mr. Bayer expressed the belief that college trained men are needed in the industry, and that they will be needed more and more in the future.

●

W. W. Park of the Westinghouse Electric and Manufacturing spoke on a highly technical subject, "System Analysis by A. C. Calculating Boards", in Franklin Hall on Friday, February 24. The lecture was sponsored by the Ithaca Section of the American Institute of Electrical Engineers.

●

Every Friday noon senior mechanical and electrical engineers are having their classroom theory supplemented by non-resident lectures. Most of the lectures aim at bringing the student in closer contact with different phases of industry, personnel work in particular. Recent speakers have been:

Hart Cooke, noted designing engineer and a pioneer in the development and manufacture of Diesel engines in this country for land, air, and marine use talked on "Modern Diesel Engines", using slides to describe the manufacture and operation of these engines.

W. C. Ballard, Professor of Electrical Engineering in the E. E. School gave a thorough, interesting talk covering the subject of patents.

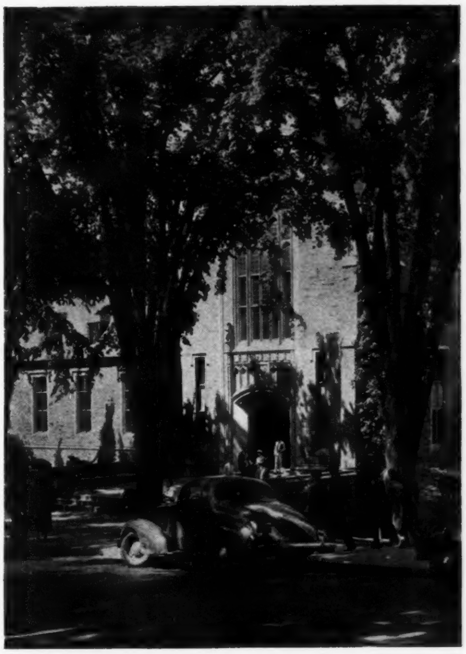
These lectures are held in Room 2 of West Sibley and, anyone having a dead hour Friday noon will find it well worth his time to sit in on them.

●

Those among us who are fortunate enough to drive cars, jaloppies, rolling coffins or what have you, will be glad to hear that a study of traffic conditions has been made, even if nothing in particular comes of it.

Nigel Thomas, senior in Civil Engineering, won a $25 prize for his thorough study of Ithaca's traffic problems, and presented a set of recommendations for improvements. He suggests that traffic lights should be reset for more adequate control of traffic, and that they should be controlled from police headquarters. "Reset" sounds like a somewhat ambitious term, since we have yet to figure how they are set at present, unless control is by some sort of a roulette wheel system.

Thomas also suggests that meters be installed to solve the parking problem. It's probably a good idea, but we would hate to have to run out of the movies every half hour or so to drop another nickle in the slot. Routes in and out of town should be improved and through traffic rerouted around congested points. Probably the suggestion which would find the most favor with students is the repaving of Seneca and Buffalo Streets. If they had any paving material left over, we wouldn't object to their putting a little of it on South Avenue. Ithaca may be famous for its gorges, but it is most disconcerting to find them turning up right in the middle of the street.



—Courtesy of Baldwin Southwark

WILLARD STRAIGHT HALL

Speaking on the "Manufacture of Sulphite Paper", P. V. Riera, '40 A.E. won the public speaking contest of the Cornell Student Branch of the A.S.M.E. held Tuesday evening, March 28. He received a book prize and qualified for the regional contest, to be held in Ithaca as part of the program of the A.S.M.E. regional convention, April 14 and 15. K. B. Turner, '40 M.E., who spoke on "Metal Aircraft Production Methods" was named alternate for the regional contest. The third speaker was F. E. Hutchinson, Jr., 40 M.E., who spoke on "Rotary Drilling of Oil Wells."

The judges were Professors F. O. Ellenwood and C. W. Armstrong of the Sibley School of Mechanical Engineering, C. F. Hager of the Department of Public Speaking, and two seniors, R. G. Smith and Robert Mann.

●

The 9th semi-annual Eastern Photoelasticity Conference will be held at Cornell on Saturday, May 13. The committee on local arrangements, of which Professor F. G. Switzer is chairman, expects an attendance of approximately 100 scientific workers in this field, both from college faculties and from the research staffs of various industries. The program of technical papers will be supplemented by an exhibit of the latest equipment for photoelastic research, and demonstrations in the Cornell laboratories. A special program is being prepared for wives of those who attend the conference.

●

The various sub-committees in charge of Cornell Day exhibits of the engineering schools have been busy lately on plans for a bigger and better show than ever. Rumor has it that among the new exhibits this year will be a model railroad in the Civil Engineering school, a model coal distillation plant in the Chem school, and a set-up similar to the Philco mystery control in the Electrical school.

NEW PUBLICATION BOARD

The CORNELL ENGINEER takes pleasure in announcing the Publication Board for the coming year.

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A party of 25 third and fourth year students in the School of Chemical Engineering, supervised by Director F. H. Rhodes and Professors C. C. Winding and O. J. Swenson, spent the week of April 2 in Philadelphia and vicinity, inspecting chemical engineering plants. They traveled by special chartered bus, leaving Ithaca Sunday, April 2, and returning Saturday, April 8.

Monday they spent the entire day studying oil refining in the refinery and research laboratories of the Socony-Vacuum Oil Company at Paulsboro, N. J. Tuesday they visited the John T. Lewis Company plant, which manufactures lead products and paint pigments, and the Pennsylvania Sugar Company plant, which produces sugar, industrial alcohol, and "dry ice", both in Philadelphia.

Three additional Philadelphia companies were visited Wednesday, Leads and Northrup and the Brown Instrument Company, makers of instruments, and the C. Schmidt and Sons brewery. The last two days were devoted to inspecting various branches of the I. E. duPont de Nemours Company. Thursday the group visited the Dye Works at the Penns Groves plant across the river from Wilmington, Del., and Friday the Kreb's Pigment division in Newport, Delaware, and the Hercules Experiment Station, where resins, varnish, explosives, and other products are originated and tested, in Wilmington, Del.

●

Names of seven students who survived the preliminary tryouts and will take part in the annual Fuertes Memorial Contest in Public Speaking on the evening of Friday, April 21, have been announced by Professor C. E. O'Rourke, chairman of the committee. Prizes of $80, $40, and $20 will be awarded from a fund given Cornell University by Charles H. Baker '86 in memory of Estevan A. Fuertes, first dean of the School of Civil Engineering. Juniors and seniors in engineering and architecture are eligible.

Contestants were selected Friday, March 24, on the basis of written papers and six-minute speeches. Their names and subjects follow: R. B. Roe '39 E.E., "Aeronautical Engineering at Cornell"; M. R. Duncan '39 E.E., "Regulation of Radio Broadcasting in the United States"; R. J. Reeves '40 C.E., "Federal Aid in Irrigation Projects"; W. N. Freeman '40 C.E., "Peace-time Planning for Air-Raid Protection"; Dorothy Hickey '39 Arch., "Art—Its Function and Rewards"; Karl J. Nelson '39 Chem. E., "Chrome-nickel Steels vs. Cast Iron in Nitrator Construction"; and Dana B. Waring '39 M.E. "Grand Coulee—White Elephant."

Judges of the preliminary contest were Professors C. E. O'Rourke, H. C. Perkins, M. G. Northrop, C. C. Winding, J. A. Hartell, and E. M. Strong, and A. M. Barnes, instructor in Public Speaking.

●

The illustration on this month's cover is from the files of the photo-elasticity department at Cornell. In this work, transparent plastics geometrically identical to structural parts are loaded in a testing machine and photographed while illuminated with polarized light. In this way stress concentrations are discovered.

●

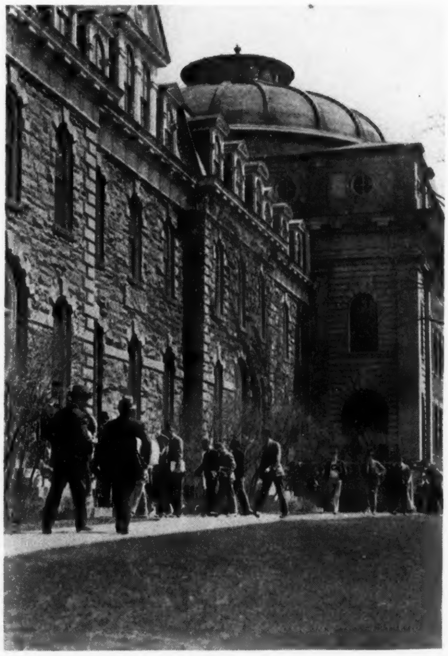
Professor Lyman P. Wilson of the Cornell Law School addressed senior mechanical and electrical engineers Friday, March 24. His subject was "Dont's for Expert Witnesses." A student of evidence for many years, Professor Wilson has gathered an unusual collection of exhibits used in famous trials.

●

Atmos, Honorary Society in Mechanical Engineering announces the election of nine Juniors: Beach Barrett, J. T. Collins, W. T. Fine, J. V. Flynn, R. F. Haller, T. C. Koo, M. N. Marsilius, Jr., J. R. Riley, Jr., and VanWormer Walsh, Jr.

●

Eta Kappa Nu, Honorary Society in Electrical Engineering, announces the election of the following men: R. Meachem, I. M. Saffitz, B. E. Nelson, O. J. Glasser, all of the class of '40.



—Courtesy of Baldwin Southwork

SIBLEY DOME

CORNELL SOCIETY *of* ENGINEERS

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80 Park Place, Newark, N. J.

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107 East 48th Street, New York, N. Y.

DAVID HARMON '31, Recording Secretary
21 Audubon Avenue, New York, N. Y.

"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates and former students and to establish a closer relationship between the college and the alumni."

President's Column

Fellow Engineers:

The matter of placement of engineers is one in which our society is keenly interested. This is not a new aim, because for many years the society has taken an active part in assisting Cornellians to find positions. In the early days, this function was carried out by various members at their own expense and time. Since the Cornell Club in New York and, later, the University established placement bureaus to furnish guidance and advice to all former students who desired it, and to recommend qualified men to employers, this work of helping our engineers has been handled by these bureaus.

The importance of this function of the University in the interest of its former students can hardly be overstressed. Other institutions of learnalso support similar placement work, so that actually there is a wide field of competition. Our interests can be most effectively served by the increased support of all concerned. In recognition of this fact, the Executive Committee, at the last meeting, authorized a contribution of $100 to the University, the same as was done a year ago. It is the feeling that this work on the part of the University can justifiably be increased and broadened in its facilities and in its scope.

David Harman '31
Recording Secretary

Cornell engineers are asked to assist by referring openings to these bureaus, and by informing Cornellians who need opportunities and desire a change, about their services. The Cornell Club Employment Service is located at 107 East 48th Street, New York City, and Mr. Paul O. Reyneau is Director. The University Placement Bureau is in Ithaca, under the direction of Mr. Herbert H. Williams.

Sincerely yours,

Walker L. Cisler
President

From the Retiring Editor:

Those of us that have had the privilege of managing the Cornell Engineer for the past year have enjoyed our relationship with the Cornell Society of Engineers and its officers with whom we have dealt. We hope that through the illustrations as well as the messages that have appeared on this page monthly the members have become better acquainted with their officers and fellow workers. These are some of the men who are seeking to aid the College of Engineering and its alumni through the promotion of the Society.

We take pride in announcing the newly elected student officers of the Cornell Engineer, who are prepared to cooperate wholeheartedly with the Society throughout the coming year.

We point to the enlargement of the Senior Board at this time to provide a better organization to care far an enlarged staff, and have listed these new student officers on page 18 of this issue. These men are capable of carrying on in a business-like, efficient manner, and feeling that they have a really worthwhile advertising medium on their hands, we sincerely hope that you will support their plans for bettering the publication by placing before Cornell students and alumni your message or that of your firm. When you send for details you will be impressed by the representative audience your advertisement reaches.

Alumni News

DR. DANIEL WEBSTER MEAD, CE '84, was presented the Washington Award for 1939 "in recognition of pre-eminent service in advancing human progress' in Chicago on February 20. The award is given annually by the Western Society of Engineers on the recommendation of a commission including representatives of the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers. Former recipients include Herbert Hoover, Orville Wright, Michael Pupin and Charles F. Kettering. Dr. Mead is the fifth civil engineer to receive the award.

Following his graduation from Cornell in 1884, Dr. Mead spent a short period with the United States Geological Survey, becoming city engineer of Rockford, Illinois and engineer of the Rockford Water Power Company in 1885. He began a professional career in public water supply and hydraulic engineering that became international in scope in the following half century.

In 1904 he accepted a call to organize a department of hydraulic engineering at the University of Wisconsin, and headed that department for twenty-seven years until his retirement in 1931.

In 1914 he was a member of the Commission of the Red Cross and Chinese Republic for Flood Protection of the Huan River; from 1913-1920 was consulting engineer of the Miami Conservancy District; and in 1928 was appointed by President Coolidge to the Colorado River Board to pass cn plans for the Boulder Canyon Project. He also reported for the chief of the U. S. Army Engineers on the foundations of Muscle Shoals Dam, and is chairman of the Board of Review of the Chicago Sanitary District for the PWA.

Dr. Mead has received numerous awards, including the Fuertes Gold Medal of Cornell University, the Octave Chanute Medal of the Western Society of Engineers and the Norman Medal of the American Society of Civil Engineers. He was awarded the degree of Doctor of Laws by the University of Wisconsin in 1932. To these honors is now added the Washington Award, conferred upon him "for his superior contribution to sound theory, good practice, and high ethical standards in the creation of engineering works as an engineer and as a teacher."

ELLWOOD BURDSALL, B.M.E. '78, died at his home in Port Chester on March 10, 1939. He had been president of the First National Bank and Trust Company of Port Chester since 1915 and was secretary and treasurer of the Russell, Burdsall and Ward Bolt and Nut Company.

STANLEY A. HAYES, ME '91, is head of the Hayes Track Appliance Company, makers of Hayes derails, Hayes bumping posts, and Hayes wheel stops, Richmond, Indiana.

F. MALCOLM FARMER, ME '99, has received the nomination for the presidency of the American Institute of Electrical Engineers. He is now vice-president and chief engineer of the Electrical Testing Laboratories in New York City. He received his early experience with the General Electric Company and with the U. S. Navy at the Brooklyn (N. Y.) Navy Yard. He joined the staff of the Electrical Testing Laboratories as a technical assistant, becoming engineer in 1906, chief engineer in 1912 and vice-president in 1929.

Mr. Farmer has been particularly active at various periods in several standardization organizations, including the American Society for Testing Materials, Standards Council of the A. S. A., and the American Society of Mechanical Engineers. He is the author of a book on electrical measurements and of numerous papers before engineering and technical societies.

HOWARD CAMERON RICE, ME '05, died March 5, 1939, at his home, 649 West Ferry Street, Buffalo. He was president of C. Kurtzmann and Company, which he joined in 1915, and Kurtzco Distributors, Inc. From 1905 to 1915 he was with the Buffalo Forge Company.

(*Continued on page* 22)

Alumni News

R. W. TASSIE, ME '09 has been recently placed in charge of the American and Foreign Power Company interests in Brazil. His new address is Caixa Postal 883, Rio de Janeiro, Brazil, South America.

JOHN JACOB SERRELL, ME '10, passed away January 12, 1939, in Philadelphia, Pa., following a brain operation January 5th. He has been a partner of Robert A. Smith '05 in Smith and Serrell, coupling manufacturers, Newark, N. J., since 1912. Sons, John J. Serrell, Jr. '37, Morton A. Serrell, '40, Victor E. Serrell '41. Seal and Serpent.

HAROLD J. SPELMAN, CE '10, has been district engineer of the United States Bureau of Roads, Washington, D. C., for the past nine years, previous to which he was chief engineer of the West Virginia State road commission. March 14 he spoke on "The Design and Building of the Sky Line Highway in Virginia "at a joint meeting of the Ithaca section of the A.S.C.E. and the Steuben area chapter of the New York Society of Professional Engineers.

LYNN CRANDALL, CE '10, was unanimously re-elected watermaster for the 10th consecutive year on March 6 by the Snake River water-users at Idaho Falls, Idaho. As watermaster, he has charge of the distribution of the waters of Snake River to 1¼ million acres of irrigated land in Southern Idaho.

THOMAS W. BLINN, CE '12, is a railroad engineer, lives at 13288 Lauder Avenue, Detroit, Michigan. His wife died last October 27; his son, Thomas Clay Blinn, "intends to take up an engineering course at Cornell about 1943. He enters high school this fall."

WILLIAM EDWARD BEITZ, CE '12, passed away February 3, 1939, in Rio de Janeiro, Brazil. He had been United States Consul in Brazil since January, 1937, previous to which he was consul in Berlin, Germany, and Vancouver, B. C. During the war he was captain in the 14th Field Artillery, Fort Sill. From 1912 to 1917, he was an instructor in Civil Engineering.

WALTER S. FOGG, ME '12, who is engaged in industrial advertising was recently elected treasurer of the Eastern Industrial Advertisers, the Landsdowne, Pa., chapter of the National Industrial Advertising Association. He has also been re-elected president of the Philadelphia Assembly No. 4 of the Society of American Magicians. His address is 67 Plumstead Avenue, Lansdowne.

WILLIAM J. ZABEL, CE '14, is with the Canal Harbor Terminal, Rochester, where he lives at 118 Clifford Avenue.

HAROLD EDWARDS, ME '14, of the O. M. Edwards Company, Inc., Syracuse, will attend his twenty-fifth reunion in June.

BERNARD J. HARRISON, CE '20, is sales manager of the Concrete Plank Company, manufacturers of precast concrete slabs or planks for floors and roofs of buildings. He lives at 1072 Hunter Avenue, Pelham Manor.

WADE W. MAC CONNELL, ME '29, is a manufactured gas engineer with the Queens Borough Gas and Electric Company, Rockaway Park, N. Y. He lives at 133 Raymond Street, Rockville Centre.

J. NORTON EWART, EE '29, has been named superintendent of the River Road Steam Station of the Buffalo Niagara Electric Corporation. He entered the employ of the company in 1929 as an assistant field engineer.

KARL T. DREHER, CE '33, is a civil engineer with the United States Bureau of Reclamation in Denver, Colorado. He was married recently; lives at 1263 Pearl Street, Denver.

ABDULKADIR A. KHAYYAT, CE '37 is an assistant engineer with the Public Works Department of Mosul, Iraq.

PETER B. RUTAN, ME '37 is with the Owens-Corning Fiberglas Corporation, Toledo, Ohio, where he lives at 1621 Woodlawn Avenue.

THEODORE C. REHM, EE '37 is a member of the technical staff of the Bell Telephone Laboratories. He lives at 327 Burhans Avenue, Haledon, Paterson, N. J.

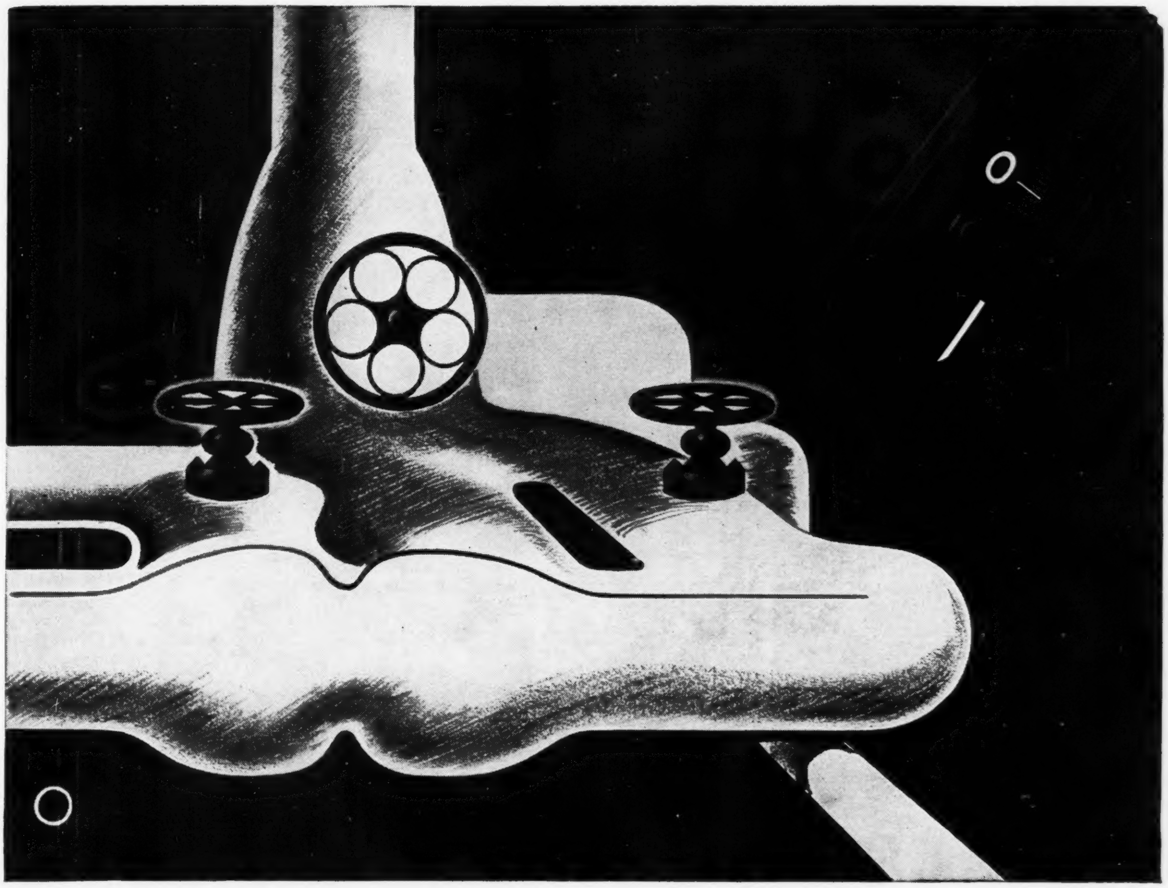
ROLAND T. FREIDAY, BS in AE '37 is with the Ingersoll-Rand Company, 2834 East Grand Boulevard, Detroit, Michigan.

FRED F. SAMPSON, JR. BS in AE '37, is a salesman with the Owens-Corning Fiberglas Corporation. His address is 1621 Woodland Avenue, Toledo, Ohio.

HUGH M. ATWOOD, ME '38, son of Edward H. Atwood, '10, is with the General Electric Company in the student training course. His address is in care of the Company, 6901 Elmwood Avenue, Philadelphia, Pa.

DAVID BENJAMIN, ME '38, former managing editor of THE CORNELL ENGINEER, living now at 225 West Eighty-sixth Street, New York City, writes, "Am in the municipal civil service, with the title of topographical draftsman, but do all sorts of engineering work, from surveying and drafting to estimating and stoking the pot-bellied stove in our field office. Took a week's vacation and spent it in Stowe, Vermont, skiing."

JAMES L. LILLY, ME '38, is engaged to Elfrede M. Plaisted '39. Lilly is in the door department of the Truscon Steel Company, Youngstown, Ohio.



COPPERWELD WIRE

(*Continued from page* 9)

with loose electro-magnetic coupling between the two. When sixty cycle current flows through the primary circuit, it sets up a magnetic flux in the probe, which in turn excites the secondary winding. The amount of the magnetic flux can be increased by the presence of magnetic material at the end of the probe, thereby increasing the current in the secondary winding. Due to the shape and size of the probe, the increase of this flux can be made to depend mainly upon the distance between the end of the probe and the magnetic specimen, or in other words, upon the thickness of the copper between the end of the probe and the steel core of the wire. This type of equipment has been in service in the plant of the Copperweld Steel Company and has been used for several years for measuring the copper thickness on millions of pounds of wire. It has been tested and checked by the older methods and has been found to be an entirely reliable method of measuring copper thickness on copper covered steel wire. Now, with many refinements of design, these instruments are used to gauge copper thickness on every coil of Copperweld wire.

Two grades (breaking strengths) of this wire, known as " High Strength" and "Extra High Strength" are regularly manufactured. High strength wire has a tensile strength of 120,000 to 140,000 pounds per square inch, while extra high strength wire has a tensile strength of 160,000 to 180,000 pounds per square inch.

Copper-covered wires and strands are used by electric light and power companies for overhead ground wires (strands) on transmission lines; for pole guys; as messengers for supporting aerial power cables; and for transmission telephone lines. Various combinations of Copperweld and copper wires in the form of 3-wire, 7-wire or 19-wire strands are widely used for power conductors. Also copper-covered steel ground rods in diameters ranging from 3/8" to 1" and in lengths from 5 to 20 feet are used for driven electrical grounds.

In the telephone field, copper-covered wire is extensively used as "drop wire" for connecting the subscribers' premises to the telephone company's lines; for pole guys and aerial cable messenger, and for telephone line wire.

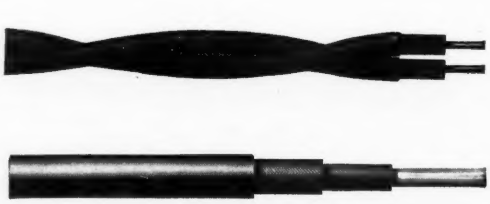
Railroads use copper-covered wire and strands for signal rail bonds, to complete the electrical circuit from rail to rail for signal purposes; for pole guys and aerial cable messenger; for overhead ground wire on electric transmission lines, and for signal line wire. Great numbers of ground rods for driven electrical grounds are also used by the signal, telephone, telegraph and electrical departments of railroads.

Copperweld-Copper catenary messenger cable, usually made up of seven copper-covered strength wires surrounded by twelve solid copper conductor wires, has been extensively used as a combination conductor and contact wire support on railroad electrification projects. This catenary messenger cable was used on the recently completed Pennsylvania Railroad electrification between Paoli and Harrisburg.

Composite conductors of this same type are frequently used for extremely long spans on transmission lines where these lines cross rivers or valleys. Many such long spans are a mile or more between supporting towers. On two recent lower Mississippi river power line crossings, these conductors were used on the 6,000 foot river spans.

With the advent of rural electrification in the United States, engineers asked for a high strength, low cost conductor, which safely could be strung on long spans to reduce the per mile cost of poles, hardware, insulators, etc. This demand was met by Copperweld-Copper conductors made of one copper-covered "strength wire" and two solid copper "conductor wires," in the form of a 3-wire strand. These rural line conductors were designed to combine the high electrical conductivity of copper with the high strength, and non-rusting characteristics of copper-covered wires. They have electrical conductivity up

Solid Copperweld wire is made in 30% and 40% conductivity grades, and in two breaking strengths, High Strength and Extra High Strength.



Insulated "Copperweld wires", single conductor and twisted-pair telephone drop wire.

to No. 2 A. W. G. copper equivalent, with strengths well suited for the economical construction of overhead lines. The 3-wire design of these conductors makes them practically free from line vibration and their large individual wires provided a very substantial and rugged conductor design.

For rural lines, these 3-wire strands offer one of the simplest means of avoiding vibration difficulties. In the smaller sizes 3-wire strands are much superior to solid wires and the larger sizes of 3-wire strands are generally preferable to smaller 7-wire stranded conductors. The shape of the latter approximates that of a round conductor and is not sufficiently irregular to disrupt air eddies which cause vibration. The greatly reduced vibration tendencies of 3-wire strands practically insures these conductors against all vibration difficulties.

Other uses for copper-covered wire include the manufacture of stiff, non-rusting nails and staples, fences that combine the rust resistance of solid copper with the strength of steel, non-rusting anchor rods and special non-rusting wire for many mechanical purposes.

One of the most interesting of these mechanical uses for the wire will be found in connection with flood control work done by Army Engineers along the Mississippi River. Articulated (flexible) concrete mats, reinforced and tied together by Copperweld wire have been laid along the banks of the Mississippi River at many points as a means of preventing bank erosion with resultant destruction of expensive levee works. Wire (.204″ diameter) was used for reinforcing fabric in these mattresses and wire and strand was used for anchoring them in position on the river bank.

After more than 100 years of development work, and with the aid of modern metallurgical, production, and inspection methods, copper-covered steel wires are being produced that at last combine all the desirable characteristics of both copper and steel.

●

PLANT DESIGN REPORT

(*Continued from page* 11)

reburned material. Theoretically, the plant could operate entirely on the reburnt lime but there is some handling loss and enough of the calcium carbonate filter cake is discarded so that there will be 10 per cent replacement to prevent the accumulation of impurities in the lime.

Fresh lime from an outside silo is moved to the fresh lime hopper by a conveyor and bucket elevator. The reburnt lime from the kiln is moved by conveyor and bucket elevator to the hopper for old lime. Each of these hoppers contains about a one-day supply of lime.

The lime from these two hoppers is distributed through automatic feeders into a rotary lime slaker, as shown. The amount of solution added is regulated so that the resulting slaked lime is practically the dry hydrate; some excess solution must be used because the heat of slaking evaporates considerable water.

The slaked lime passes into a bowl classifier, which removes any grit and hard particles of unburnt limestone and overburnt lime. A weak liquor is added to the lime in the classifier so that a strong milk of lime containing about 250 grams of lime per liter is obtained. This suspension is heated by steam to a temperature of 90° C, before it enters the first of the causticizing agitators.

The causticizing operation to a great extent determines the rate of settling or separation of the solid calcium carbonate precipitate in the separator or thickener. The rate of settling is very important; the entire process may be delayed if it is too slow. The rate at which a precipitate will settle through a still liquid depends on four factors:

(1) the size of the particles,

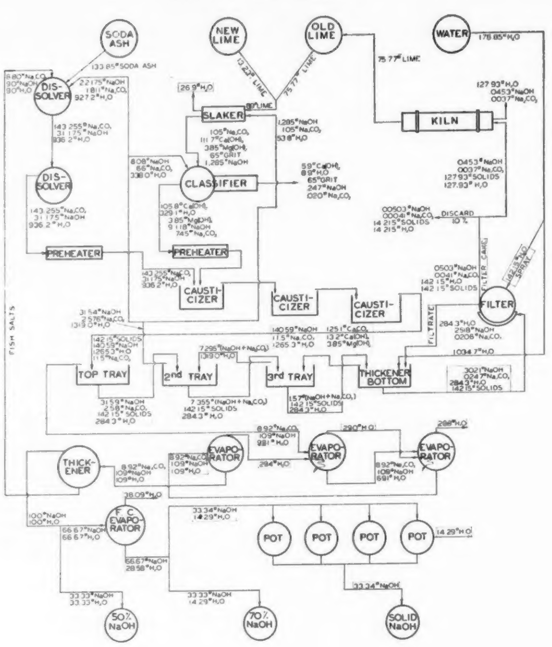
(2) the shape of the particles,

(3) the difference in density between the solid and the liquid in which it is suspended,

(4) the viscosity of the liquid.

With these factors in mind, work has been done to determine conditions which would give a fast rate of settling of the $CaCO_3$ formed by the reaction which

KINEMATIC FLOW SHEET
BASIS 100 LB. NAOH PRODUCED



takes place in the cauticizers:

$$Na_2CO_3+Ca(OH)_2NaOH+CaCO_3$$

Care must be taken to use a good grade of "high calcium" lime in which the MgO is held to a minimum. Different settling characteristics are obtained by the use of lime from different sources; it is advisable to make settling tests on a sample of each new batch of lime which is obtained. The burning of the lime also has an effect on settling. Overburned lime and reburned lime settle faster, everything else being equal. The slaking process also has an effect on the rate of settling. A slight excess of water in slaking gives good settling. The method of slaking to approximately the dry hydrate and then adding the rest of the water in the classifier produces better settling characteristics. In general, the coarser the solid particles, the higher the temperature of the solution during causticization (within limits), and the more dilute the lye, the better is the settling rate of the calcium carbonate. The temperature range which is practical for the reaction is from 80° to 100° C. Long and violent agitation must be avoided, or the particles become too finely broken up and settling is retarded. The concentration of the solution is determined by a balance of several factors. A dilute solution favors settling and good conversion of Na_2CO_3 to NaOH. A stronger solution gives poorer settling and poorer conversion but there is less water to remove in concentrating the caustic soda.

Experimental work was done to determine the proper excess of lime to use in causticization and the percentage conversion obtained. Any excess of lime above 5 per cent gives approximately the same conversion but some excess should be used. The experimental work showed that the percentage conversion was about 92 per cent under practical conditions, although the figure was raised slightly by long retention in the causticizer. This result agrees very well with the results obtained in various industrial caustic plants.

As a result of the above studies, the plant has been designed to operate using 5 per cent excess lime in the causticizers, yielding a 10 per cent solution of NaOH. Conversion of 92 per cent is assumed, using three causticizers at 90° C. with a total retention of one hour. Agitation is provided by turbine-type agitators, which operate within a peripheral speed limit at 750 feet per minute.

The separator consists of a Dorr 4-tray washing type thickener. The top tray acts merely as a separator, the overflow being the 10 per cent caustic solution (containing a little unconverted Na_2CO_3) which is sent to the evaporators for concentration. The underflow is $CaCO_3$ sludge containing 2 parts of water by weight to each part of solid. The three lower trays of the thickener comprise a system of counter-current washing which removes practically all of the alkali from the sludge. The quantity of hot wash water is adjusted so that there will be the proper amount to give a 10 per cent caustic solution from the causticizers. The solids from the bottom tray are pumped by means of a diaphragm pump to a rotary filter.

By the use of the washing type thickener and the filter a 99.7 per cent recovery of alkali is obtained. Ten per cent of this cake is discarded to waste without reburning. The remaining cake is fed into a continuous rotary lime kiln in which the $CaCO_3$ and the small amount of $Ca(OH)_2$ are burned to lime (CaO). The reburnt lime from the kiln is taken directly by conveyor and elevator to the hopper for old lime.

The 10 per cent caustic solution which overflows from the top tray of the thickener is piped to the middle effect of a triple effect evaporator. In this equipment, the solution is concentrated to 50 per cent NaOH.

Standard vertical evaporators will be used in all three effects and the three will be identical. The possibility of using forced circulation evaporators, with the correspondingly higher rates of heat transfer, was also considered. It was decided that the cost of providing power for this forced circulation more than offsets the decrease in heating surface and size of the evaporators. The standard vertical evaporator gives fairly good circulation and coefficients of heat transfer and requires no power.

It has been decided to use three effects, with the heating steam for the first effect supplied at 150 pounds per square inch. These decisions aid com-

promises, since two to four effects were considered, as was 100 to 200 pound steam. In general the steam cost is the determining factor, since it is the major portion of the annual expense on the evaporators. For this reason it is economical to use more effects, so that less steam must be supplied directly. However, it has never been found practical to use more than three effects for the first concentration of caustic soda.

In the second and third effects, cast iron will be satisfactory for the body of the evaporator and steel tubes will be used. In the first effect, which contains 50 per cent sodium hydroxide, the corrosion problem is much more important. Caustic of this strength attacks iron and steel slowly and also produces caustic embrittlement in the tubes. This would make steel tubes definitely unsafe for use with high pressure steam. It is therefore necessary to resort to different materials of construction. Monel metal, nickel, and a number of alloys withstand strong caustic quite well. Pure nickel, although expensive, is probably the most satisfactory material for such use. Therefore the body of the evaporator will be lined with nickel and the tubes and tube sheets will be of pure nickel. Such tubes in actual use in strong caustic with high pressure steam have shown no appreciable corrosion after several years.

The evaporator system is operated under a vacuum, or rather a vacuum is applied to the third effect. An assumed vacuum of 26 inches of mercury is obtained by the use of a barometric multi-jet condenser. Such a condenser readily produces the required vacuum, even with rather warm water, and in addition no air removal apparatus is necessary.

One-third of the product from the evaporators is removed and sent to a large storage tank to be sold as 50 per cent sodium hydroxide. The remaining two-thirds of the 50 per cent solution are sent to a single-effect forced-circulation evaporator. Forced circulation is used in this case due to the high concentration of the solution and the smaller volume to be handled. This evaporator will concentrate the solution to 70 per cent. Again it is necessary to resort to pure nickel heating tubes and to an evaporator body made of steel lined with nickel. Vacuum will be used with 150 pound heating steam as before. The vacuum is produced by a barometric multi-jet condenser.

The thick 70 per cent liquor from this evaporator is divided into two parts. Half of the solution is removed to a large storage tank to be sold as 70 per cent NaOH. The other half of the 70 per cent liquor is sent to the caustic pots, in which the remaining water is removed and the pure caustic soda produced.

In heating a charge in a caustic pot, the temperature is raised slowly. The initial boiling soon subsides but the temperature continues to rise. Finally small bubbles come flickering through the molten mass. At this point, the temperature is about 500°C.

After another hour, the fire is slowly withdrawn and the pots are allowed to cool until a temperature of about 350°C is reached. Then an air-driven vertical centrifugal pump is lowered in and the molten caustic is pumped into steel drums. If desired, the caustic may be pumped to a drum flaker instead of to drums; this plant is designed only for solid caustic soda. The settling of the molten caustic requires from 16 to 24 hours and the complete cycle of operation will require about three days.

The drums for the caustic each contain 700 pounds net of solid caustic. The mass solidifies on cooling and the drum is immediately sealed to prevent the absorption of moisture. This is the commercial 76 per cent (Na_2O) caustic which contains well over 98 per cent NaOH.

Cost Summaries

The following tables present a brief summary of production costs on an annual basis. In arriving at the annual cost of the process, it is necessary to evaluate these charges:

1. Interest on the investment.
2. Taxes and insurance.
3. Depreciation.
4. Maintenance.
5. Power, steam, water and fuel.
6. Raw materials.
7. Labor.
8. Overhead.
9. Sales costs.

Because of the items, such as depreciation, that varied with the various pieces of equipment, it was necessary to calculate the individual charges against each piece of equipment. The costs given below show only the total overall sum of these costs for the entire plant.

Manufacturing Costs

(Annual Basis)

Equipment	$ 40,941.00
Building	34,119.00
Power	4,672.37
Steam	72,985.00
Water	17,248.00
Fuel Oil	111,350.00
Labor	61,320.00
Lime at $8.50 per ton	20,520.00
Soda Ash at $1.10 per 100 lb.	537,410.00
Total Manufacturing Cost	$900,565.37
Administration and Sales at 5% of the Total Manufacturing Cost	45,028.27
Total Annual Cost	$945.593.64

Gross Income

Solid NaOH (35,500,000/3 lb. at $2.60 per 100 lb.	$316,500.00
70% NaOH (36,500,000/3 lb. at $2.27 ½ per 100 lb.	277,000.00
50% NaOH (36,500,000/3 lb. at $2.22½ per 100 lb.	270,500.00
Total Gross Income	$864,000.00

Summary

Capital Investment			
Equipment	$128,781.55		
Building	200,700.00		
Total Capital Investment	$329,481.55		
Fixed Charges			
Annual Costs	Annual Cost	% of Total	$/100 lb.
Equipment	$ 40,941.00	4.33	$0.112
Building	34,119.00	3.62	0.094
Operating Costs			
Power	4,672.37	0.49	0.013
Steam	72,985.00	7.72	0.200
Water	17,248.00	1.82	0.047
Fuel Oil	111,350.00	11.79	0.306
Labor	61,320.00	6.49	0.168
Lime	20,520.00	2.17	0.056
Soda Ash	537,410.00	56.80	1.471
Administration and Sales	45,028.27	4.77	0.123
Total	$945,593.64	100.00	$2.590
Gross Income			
Solid NaOH	$316,500.00		
70% NaOH solution	277,000.00		
50% NaOH solution	270,500.00		
Total Gross Income	$864,000.00		
Net Income			
Net Loss	$ 81,593.64		

Conclusion

The cost summaries, as presented, do not represent an entirely accurate picture of the situation. There are without doubt errors and omissions. In most cases, assumptions have been made considerably on the safe side, so that the total annual costs are very possibly higher than would occur in actual operation.

The greatest proportion of the cost is incurred in purchasing soda ash for the process. A price of $1.10 per 100 pounds has been charged. A reduction in this price to $0.934 per 100 pounds would permit the plant to break even, without any change in the other costs. Under ordinary conditions the caustic soda plant would be operated in conjunction with a plant for the manufacture of soda ash by the Solvay Process. Such operation would undoubtedly supply soda ash for the caustic soda plant at a price well below the quoted market price and would permit the plant to show a profit. Therefore, the net loss which is shown by the cost summary should not be considered as indicative of true operation.

Although successful operation of the plant at a profit at full capacity appears very possible, it is probably unwise to construct such a plant at the present time, nor does it appear that construction in the future is very probable. Business conditions are poor and there is continued overproduction of caustic soda. The electrolytic caustic manufacturers have finally discovered what appears to be a practical method for removing the salt from their caustic, so that they have now entered the rayon field which formerly belonged exclusively to the lime-soda manufacturers. The method of salt removal consists of the precipitation of sodium hydroxide decahydrate crystals from strong caustic solution, removal of salt by wash-

ing, and then the re-dissolving of the washed crystals. The development of this process shows signs of leading to a drop in the price of caustic soda in relation to the price of soda ash. Such a drop will be fatal to the lime-soda process for caustic soda, since the electrolytic manufacturers do not require soda ash and a large portion of their cost is borne by the sale of their other product—chlorine.

At present, all prices are down, due to poor business conditions, so the true effect of the new process cannot yet be measured.

In view of present conditions, the construction of the plant seems inadvisable.

STRESS and STRAIN

Study in Elevation

This ditty is a string of lies.
But—how the deuce did Gubbins rise?

POTIPHAR Gubbins, C. E.,
Stands at the top of the tree,
And I muse in my bed on the reasons that led
To the hoisting of Potiphar G.

Potiphar Gubbins, C. E.,
Is seven years junior to Me;
Each bridge that he makes either buckles or breaks.
And his work is as rough as he.

Potiphar Gubbins, C. E.,
Is coarse as a chimpanzee:
And I can't understand why you gave him your hand,
Lovely Mehitabel Lee.

Potiphar Gubbins, C. E.,
Is dear to the Powers that Be;
For They bow and They smile in an affable style,
Which is seldom accorded to Me.

Potiphar Gubbins, C. E.,
Is certain as certain can be
Of a highly paid post which is claimed by a host
Of seniors—including Me.

Careless and lazy is he,
Greatly inferior to Me.
What is the spell that you manage so well
Commonplace Potiphar G?

Lovely Mehitabel Lee,
Let me inquire of thee,
Should I have riz to what Potiphar is
Hadst thou been mated to Me?

Under the swinging street car strap
The homely co-ed stood
And stood and stood and stood
And stood and stood and stood.

Prof.: Is that your cigarette stub?
Senior: Well, go ahead, you saw it first.

She: What's your roommate like?
He: Damn near everything I own.

Heard in P-11 recitation:
Instructor: What is the advantage of a long pump handles?
Frosh: You can get somebody to help you pump.

"Don't you think this Victrola has a beautiful tone?" said the salesman.
"No."
"Isn't it the best machine for the money?"
"No."
"But don't you think it is housed in a beautiful cabinet?"
"No."
"Say, what's your name anyway?"
"Brunswick."

"What's your name?"
"Abraham Lincoln, sir".
"A very famous name".
"It should be, I've been driving cab here for thirty year sir".